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(54) **Implant for Internal Fixation of Vertebral Bodies, and Tool for Cutting off Pedicle Screws**

(57) This implant is of simple and cheap construction and can be individually adapted to the curvature of the spinal column. For this purpose, the pedicle screws (1) are bent according to the individual curvature of the spinal column via the connection rod (2) which joins together the connection pieces (3). Clamping screws (12) are arranged in the connection pieces (3), in which a borehole (15) is provided to guide and hold fast the connection rod (2). The surface (16) of the borehole (15) is outwardly convex, and the diameter (17) of the borehole (15) corresponds roughly to the diameter of the connection rod (2) at its ends. The surface of the borehole (15) can have a circular or elliptical convexity, for example; both a straight and a curved piece (18) of the connection rod (2) can be guided and restrained and the connection rod (2) can abut against both ends of the borehole in linear fashion.

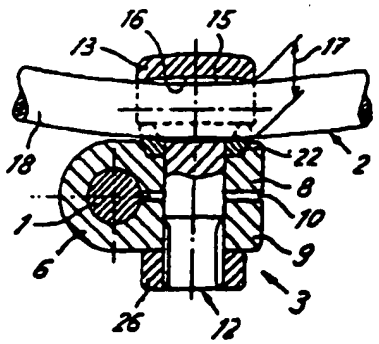


Fig. 8

Specification

The invention concerns an implant for the internal fixation of vertebral bodies and a tool for its machining, there being provided pedicle screws that are fastened in the vertebral bodies and that are joined together via at least one connection rod and connection pieces.

Such implants find application in pathological alteration (spondylosis) at vertebral bodies and intervertebral disks, correcting the position of the vertebral bodies and fixing the relative position of the affected vertebral bodies that is brought about by the correction.

From a datasheet Tape No. 20098 of the Mediothek of the College of Medicine of the University of Basel dated 20 Jan. 1988 there is a known implant according to the preamble, having a connection rod in the form of a screw spindle. The pedicle screws are held by two connection pieces, which are arranged on the screw spindle and can be adjusted by turning. An implant of this construction can only be inadequately adapted to the curvature of the spinal column.

An implant for spondylosis that has been published by *US Patent No. 5,409,488* consists of two connection pieces, which can be turned and adjusted in their distance from each other and which are arranged on screw spindles. The screw spindles are joined together by means of a third connection piece in such a way that their lengthwise axes intersect at an angle of around 15°. This is supposed to enable the adaptation of the implant to the curvature of the spinal column. The screw spindles are guided by a journal, having an annular groove, in the third connection piece, and a pin which engages in the annular groove secures the screw spindles against axial shifting. The screw spindles have a molded-on hexagon, by means of which they can be turned independently of each other. The connection pieces hold bone screws, which are screwed into the vertebral bodies. The smooth, nonthreaded shaft of the bone screws can be turned in a retention element of the connection piece and shifted in its lengthwise direction. The retention element has a clamping element in the form of a screw socket, by which the nonthreaded shaft of the bone screw can be secured. For this purpose, a two-part insertion piece is arranged in an opening of the connection piece, which has an internal thread for the screw socket in one part. In the other part, adjoining the inner thread, there is provided a conical piece of a guide borehole for the bone screw, in which a conical clamping ring having a lengthwise slit is arranged. When tightening the screw socket, the threadless shaft of the bone screw that is guided in both the screw socket and in the conical clamping ring and in the insertion piece is secured by means of the conical clamping ring. At the same time, the two parts of the insertion piece are pressed against the inner walls of the opening of the connection pieces. In order to achieve a faultless secure retention of the bone screws, the two-piece insertion element has annular grooves at its ends, in which are arranged slightly projecting split lock washers, which when the screw socket is tightened dig into the connection piece, on the one hand, and the annular grooves of the insertion element, on the other.

The above-described implant is intended to achieve a better adaptation to the curvature of the spinal column. But since the adaptation relies primarily on the given relative position of the screw spindles to each other, an adaptation to individual circumstances is hardly possible in the final analysis.

Therefore, the purpose of the invention is to propose an implant of the above-mentioned type that enables a better adaptation to individual curvatures of the spinal column.

This purpose is achieved by the invention given in Patent Claim 1. The connection rods joining the pedicle screws to each other via the connection pieces are bent according to the curvature of the spinal column. Clamping screws are arranged in the connection pieces, in which is provided a borehole for guiding and holding fast the connection rod. The surface of the borehole is outwardly convex, and the diameter of the borehole at its ends corresponds approximately to the diameter of the connection rod.

The benefits accomplished with the invention lie in the fact that an individual adaptation of the implant to the curvature of the spinal column is made possible. This is achieved, in particular, by the appropriately shaped connection rod, which is held in the borehole of the clamping screws abutting in linear fashion only at two places, while the borehole can be designed such that connection rods of the most diverse curvature can be secured. Other benefits lie in the more simple and therefore cheap construction compared to the state of the art, in particular, no screw spindles are required and the clamping and securing of a pedicle screw and the connection rod can be accomplished with only one clamping screw.

The invention shall now be explained more closely by means of several sample embodiments in connection with the drawing. This shows:

Figure 1 a side view of the implant according to the invention with two pedicle screws,

Figure 2 a section along line II-II in ***Figure 1***,

Figure 3 a section through a clamping body of a connection piece of the implant,

Figure 4 a section through a curved washer of the connection piece,

Figure 5 a partial section through a clamping screw of the connection piece,

Figure 6 a section through and a top view of the curved washer of the connection piece in another design,

Figure 7 a view of the clamping screw of the connection piece in a second embodiment,

Figure 8 a section through a connection piece with a curved connection rod at larger scale,

Figure 9 a section along line IX-IX of ***Figure 2*** on larger scale,

Figure 10 a rear view of a portion of a spinal column with two implants for four vertebral bodies,

Figure 11 a side view of a portion of a spinal column with the implants per ***Figure 10*** and a tool for cutting off the pedicle screws, and

Figure 12 another section through a connection piece.

In the figures, the pedicle screws are designated 1, being joined together via the connection rod 2 and connection pieces 3. The pedicle screws have a shaft 4 and a threaded part 5, by which they can be screwed into vertebral bodies 30 (Figures 10, 11). The connection pieces 3 consist of a clamping body 6, which has a first borehole 7 to receive a pedicle screw 1 and a slot 10 joined to the first borehole 7 and forming two spring-action clamping jaws 8, 9. In the clamping jaws 8, 9 there is a second borehole 11, intersecting the first borehole 7 and running perpendicular to the slot 10, to receive a clamping screw 12 of the connection piece 3. In a head 13 of the clamping screw 12 there is a borehole 15 running perpendicular to the lengthwise axis 14 of the clamping screw 12 to guide and hold fast the connection rod 2. The surface 16 of the borehole 15 is inwardly and outwardly convex, the diameter 17 of the borehole 15 corresponding at its ends approximately to the diameter of the connection rod 2 and the convexity being circular or elliptical, for example. In the borehole 15 of such shape it is possible to guide and secure either a straight or a curved part 18 of a connection rod 2 individually adapted to the curvature of the spinal column, while the connection rod 2 is supported in linear manner at both ends of the borehole 15 (Figures 8, 9). A transition 19 between the head 13 and a shaft 20 of the clamping screw 12 is conical in shape, while the borehole 15 extends partly in the conical transition 19.

In one clamping jaw 8 of the clamping body 6 there is provided a conical recess 21, concentric with the second borehole 11, in which is arranged an appropriately shaped curved washer 22. The curved washer 22 has a conical recess 23, adapted to the conical transition 19 of the clamping screw 12, where there is formed a margin 24, in which a portion of the borehole 15 extends.

When fixing the implant in place, both the pedicle screws 1 and the connection rod 2 are simultaneously secured by screwing a thread 25 of the clamping screw 12 with a nut 26.

According to the embodiment of Figures 6 and 7, the clamping screw 27 has two parallel flats 28, which correspond to correspondingly shaped, not precisely depicted flats in the curved washer (with lengthwise hole fitting flat 28) 29 and the second borehole 11. In this way, a twisting of the clamping screw 27 is to be prevented, and in the loosened condition it should guarantee the joint turning of the curved

washer so that in any position it is ensured that the connection rod does not slip out of the recesses and thereby be able to twist.

According to Figure 11, a tool 35 for cutting off the pedicle screws 1 to the required length consists of a cylinder 36, in which is led a rotary piston 37. The rotary piston 37 has a head 38 projecting from the cylinder 36 and an eccentric borehole 39 extending in its lengthwise direction, which is aligned with another eccentric borehole 41 situated in a bottom 40 of the cylinder 36. The two boreholes 39, 41 are intended to receive the shaft 4 of the pedicle screw 1. After the final fixation of the implant, the tool 35 is pushed up to the connection piece 3 on the shaft 4 and cuts it off by twisting the head 38 or the rotary piston 37.

List of reference numbers

1 pedicle screws
2 connection rod
3 connection pieces
4 shaft
5 threaded part
6 clamping body
7 first borehole
8 clamping jaw
9 clamping jaw
10 slot
11 second borehole
12 clamping screw
13 head
14 lengthwise axis
15 borehole
16 surface
17 diameter
18 bent part
19 conical transition
20 shaft
21 conical recess
22 curved washer
23 conical recess
24 margin
25 thread
26 nut
27 clamping screw
28 flats
29 curved washer with lengthwise hole
30 vertebral body
35 tool
35 cylinder
37 rotary piston
38 head
39 borehole
40 bottom
41 additional borehole

Patent Claims

1. Implant for the internal fixation of vertebral bodies, wherein pedicle screws (1) are provided, which are fastened in the vertebral bodies (30) and joined together via at least one connection rod (2) and connection pieces (3),
characterized in that

   - the connection rod (2) is bent according to the individual curvature of the spinal column,
   - the connection pieces (3) have a clamping screw (12) in which there is a borehole (15) for guiding and holding fast the connection rod (2), and
   - the surface (16) of the borehole (15) is outwardly convex, the diameter (17) of the borehole (15) corresponding at its ends approximately to the diameter of the connection rod (2).

2. Implant per Claim 1,
characterized in that

   the borehole (15) for the connection rod (2) is arranged in a head (13) of the clamping screw (12) and runs perpendicular to the lengthwise axis (14) of the clamping screw (12).

3. Implant per Claim 2,
characterized in that

   the surface (16) of the borehole (15) for the connection rod (2) has circular or elliptical convexity.

4. Implant per Claim 1,
characterized in that

   a clamping body (6) of the connection pieces (3) has a first borehole (7) to receive a pedicle screw (1) and a slot (10) joined to the first borehole (7) and forming two spring-action clamping jaws (8, 9), while there is arranged in the clamping jaws (8, 9) a second borehole (11), intersecting the first borehole (7) and running perpendicular to the slot (10), to receive the clamping screw (12).

5. Implant per Claim 4,
characterized in that

   the clamping screw (27) has two flats (28) running parallel to each other.

6. Implant per Claim 5,
characterized in that

   the second borehole (11) has a shape corresponding to the flats (28) of the clamping screw (27).

7. Tool for cutting off the pedicle screws of the implant per Claim 1,
characterized in that

   a cylinder (36) is provided in which a rotary piston (37) is guided, while the rotary piston (37) has a head (38) projecting from the cylinder (36) and an eccentric borehole (39) traveling in its lengthwise direction, which is aligned with another eccentric borehole (41) situated in a bottom (40) of the cylinder (36).

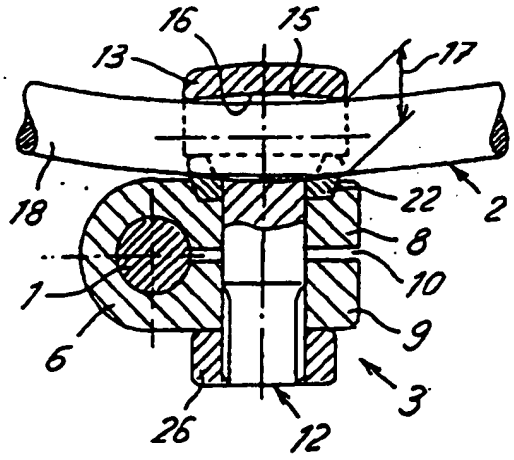


Fig. 8

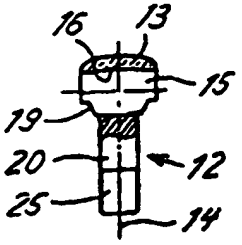


Fig. 5

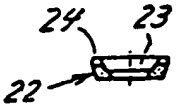


Fig. 4

Fig. 2

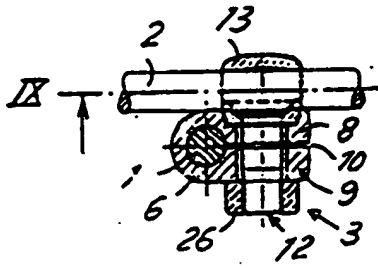
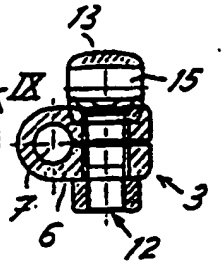


Fig. 12



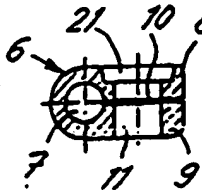


Fig. 3

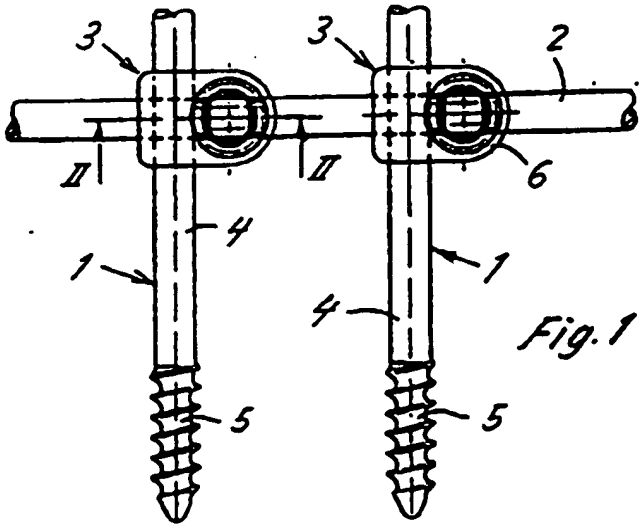


Fig. 1

Fig. 6

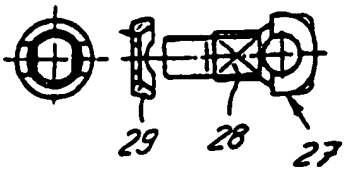


Fig. 7

Fig. 9

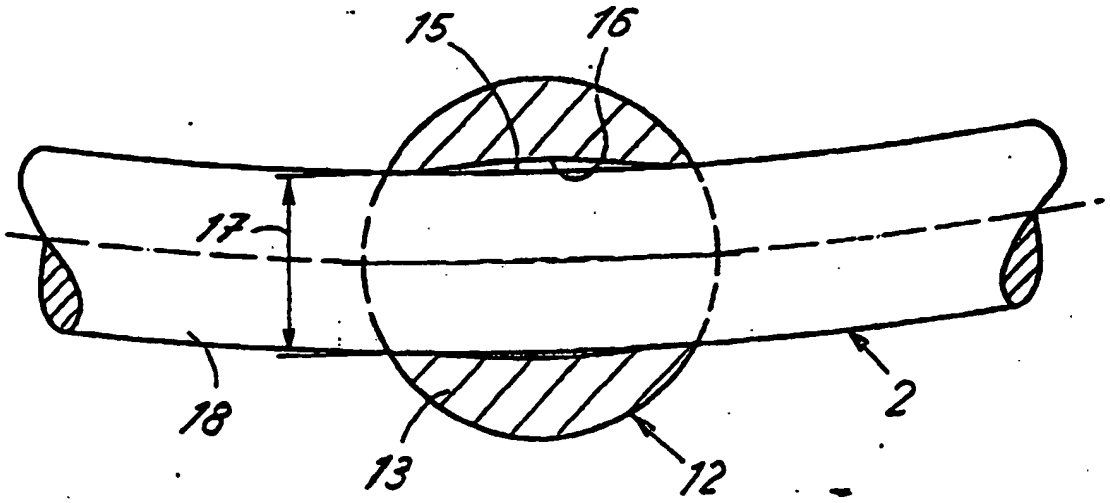
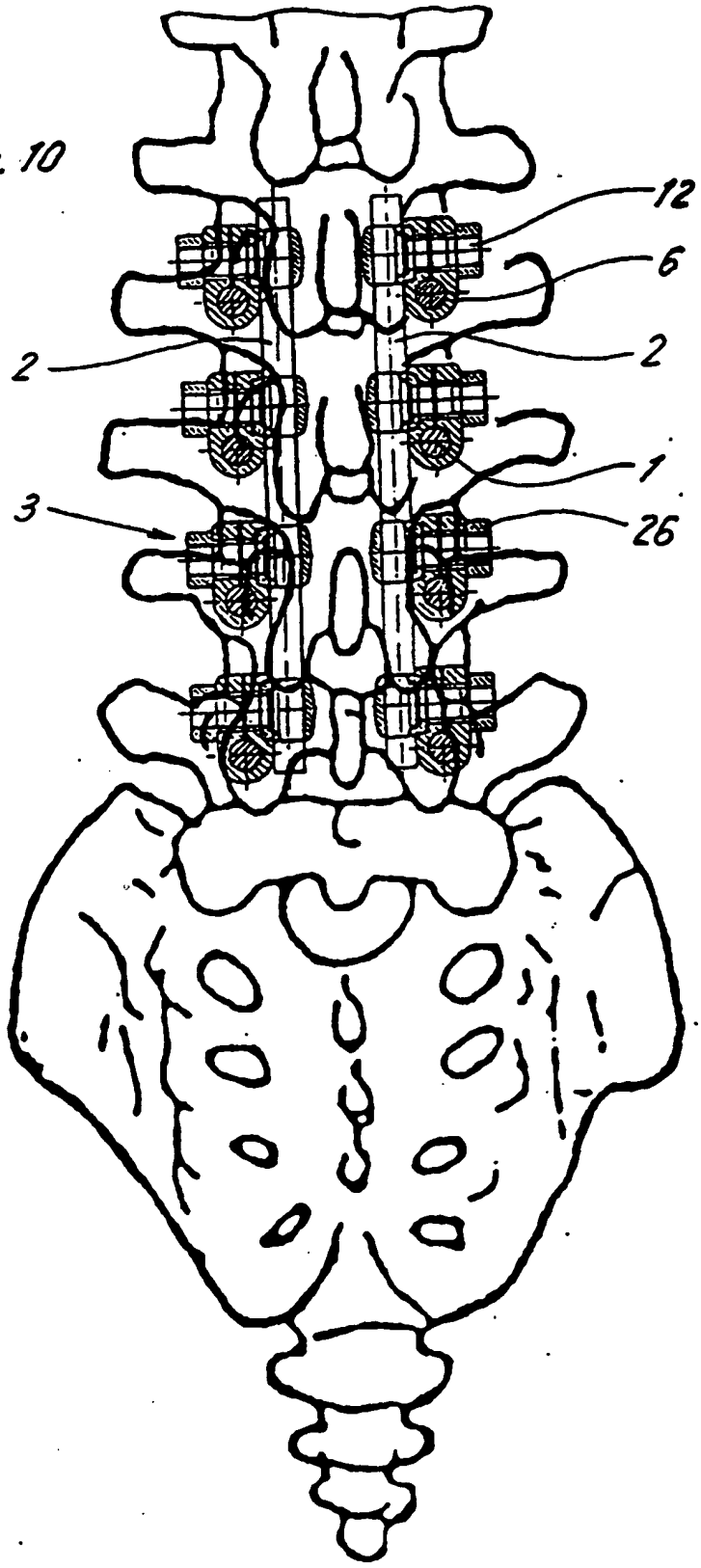


Fig. 10



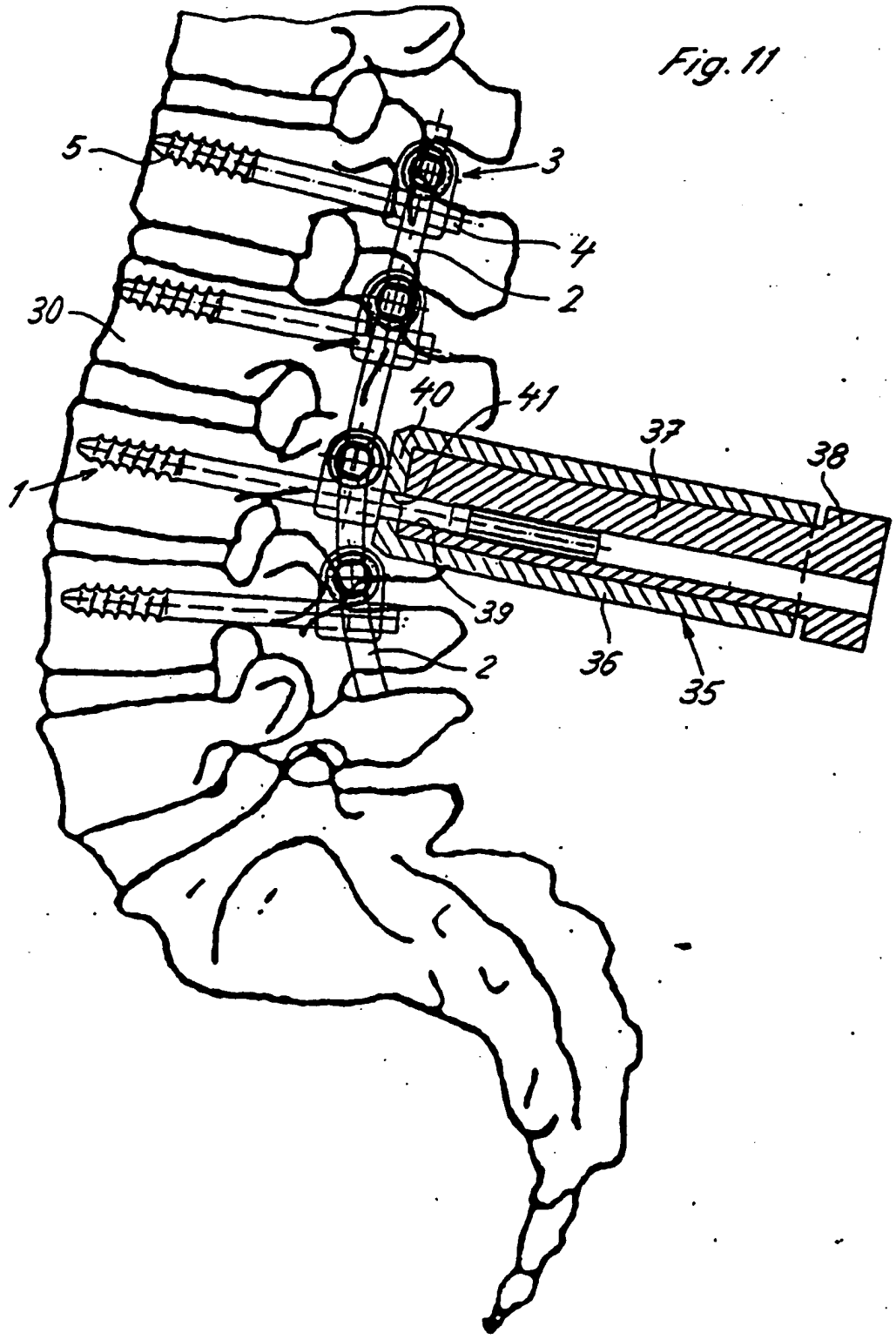


Fig. 11